

## Overview

*The Engineer's aesthetic, and Architecture, are two things that march together and follow one from the other.... The Engineer, inspired by the law of economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony. The Architect, by his arrangement of forms, realizes an order, which is a pure creation of his spirit...it is then that we experience the sense of beauty. —Le Corbusier*

The Solar Decathlon is an intercollegiate and interdisciplinary design and construction competition that takes up a persistent and age-old question: How do we integrate architecture and technology with a dwelling? In other words, what makes a good house?

More than 2,000 years ago, the Roman architect Vitruvius claimed that all buildings should possess the qualities of “firmness, commodity, and delight.” Centuries later, architects and engineers of the Industrial Revolution were inspired and challenged by the new technologies and building tasks their age presented. In the early twentieth century, the influential Swiss Modernist architect, Le Corbusier, wrote in *Towards a New Architecture*, “Let us state the problem. Let us shut our eyes to what exists. A house: a shelter against heat, cold, rain, thieves, and the inquisitive. A receptacle for light and sun. A certain number of cells appropriate to cooking, work, and personal life.”

The sources of energy that powered the Industrial Age have revealed their limitations and their consequences, as contemporary living demands more and more energy for “commodity and delight” as well as “cooking, work, and personal life.” Architecture and engineering students of today, then, face both an old and a new problem: to satisfy an age-old curiosity about dwelling while solving the relatively new problem of post-industrial energy and its consequences. The Solar Decathlon challenges engineering and architecture students to design and construct a fully self-sufficient solar-powered house. Or, to paraphrase and gather inspiration from Le Corbusier’s words: a sun-machine in which to live.

Like the athletic decathlon, the Solar Decathlon will test proficiency in a wide range of skills. Unlike its athletic counterpart, however, the Solar Decathlon is a team event, in which the diversity of abilities comes from the composition of the team rather than a single individual. Architecture and engineering students will work with students from other disciplines such as marketing, communications, graphic design, analysis, and computer science to do the troubleshooting, communicating, dreaming, and building this challenging project requires.

The third Solar Decathlon will take place on the National Mall in Washington, D.C., in the fall of 2007. For approximately 3 weeks, the Solar Decathlon organizers and teams will assemble and inhabit a “Solar Village” in view of the Nation’s capitol. When the village is fully assembled, teams will compete against each other during a week of 10 decathlon contests. The team with the highest point total at the end of the week will be the winner. Additional awards will be presented in several other categories. The village also will be open to the public and media, who will be invited to tour the teams’ homes and the educational exhibits provided by the organizers and sponsors.

The 10 contests are based on three guiding principles for the Competition:

- The teams must supply the energy requirements necessary to live and work using only the sunlight shining on their entry—the global solar radiation incident on the house, specifically—during the contests.
- The houses will exemplify good design principles that will increase the public’s awareness of the aesthetic and energy benefits of solar and energy efficiency design strategies and technologies, which in turn will increase the use of these design principles and technologies.
- The work of the teams, organizers, and sponsors will stimulate accelerated research and development of renewable energy, particularly in the area of building applications.

The following set of priorities determines what the 10 contests should encompass.

- ***Energy Production:*** Each team’s house must be able to supply all of the energy needed for its occupants to survive and prosper in today’s society. Within their comfortable and well-lit houses, the teams will perform domestic tasks that require the operation of appliances and electronics, and they will transport themselves around town in an electric vehicle—all of this with energy from only the solar electric and solar thermal systems integrated into their houses. The Competition will quantify each team’s energy production and productive output.
- ***Energy Efficiency:*** Efficiency reduces consumption and enables more work to be accomplished with a given amount of energy. Because the amount of sunlight that strikes the surface of a house is limited, end-use efficiency will be a key strategy to success.
- ***Design:*** Since the time of Vitruvius, design has been an essential part of deciding what makes “a good house.” Good design improves structural integrity (“firmness”), function and comfort (“commodity”), and aesthetic appeal (“delight”). Whether a house is a “good house” may be qualified by the architect who designs it, the engineer who optimizes its performance, the builder who constructs it, and the occupant who lives and works in it. Good design becomes more challenging as the building industry strives to integrate existing ideas and technologies with an increasing array of new ideas and technologies, many of which are just being introduced. Design is a critical part of the Solar Decathlon, emphasizing overall dwelling livability and structural and systems aesthetics and integration, especially integration of the dwelling with its energy systems.
- ***Project Documentation:*** Good design is as much a process as it is the result evidenced in the finished house. The Competition requires teams to demonstrate their design processes by providing documentation such as energy performance analyses, drawings, and design narratives at various phases of their projects.

- ***Communications:*** Effective communications save time and improve our safety and quality of life by supplying the important information we use to make critical decisions. Variety, content, and design are essential to drawing an audience to a message. Getting a clear message about delightful design, energy efficiency, and solar energy to the public audience will be an important consideration in this Competition.
- ***Heating and Air Conditioning:*** As Le Corbusier stated, a house must be a comfortable space in which to live, protected from wind and rain, from winter's snow, and summer's heat. For good health, the conditioned space must also minimize indoor pollutants. To succeed, the teams' houses must provide interior comfort and good environmental quality while meeting the energy requirements of the Competition.
- ***Appliances and Electronics:*** Household appliances and electronics have improved our quality of life since the dawning of the industrial age. They use energy to save the physical energy and time of a household's inhabitants, and they provide entertainment and access to global communications. The demand for appliances and electronics grows greater every day, even as the consequences of supplying the energy they require becomes ever more apparent. The Solar Decathlon will challenge students to meet the energy demands of domestic and working life while competing to solve the problem of the consequences of energy use in the post-industrial age.
- ***Hot Water:*** Hot running water is considered a necessity. Energy- and water-saving strategies and technologies are readily available. The Competition challenges the teams to demonstrate these options while meeting average hot water requirements for domestic activities.
- ***Lighting:*** Lighting improves our safety, productivity, and quality of life. Beyond its purely practical application, lighting also has the power to please the inhabitants of the "receptacle for light" that Le Corbusier described. The Solar Decathlon requires teams to design lighting solutions that are energy-efficient and abundant, as well as pleasing to the houses' inhabitants.
- ***Transportation:*** Mechanized transportation gives us greater freedom, saves time, and improves productivity. The Competition will reward teams that can plan their use of transportation the most efficiently and that use their houses' energy systems to provide the energy to meet their transportation needs.

## Team Selection

The Solar Decathlon is an international Competition open to all accredited colleges, universities, and other post-secondary educational institutions. Entrants are selected through a proposal process. All proposals are reviewed, scored, and ranked. Depending on the quantity and quality of submissions, a limited number of teams from all entries are selected.

For the 2007 Solar Decathlon, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) issued a Request for Proposals in October 2005. Proposals were due in December 2005. After reviewing, scoring, and ranking the proposals, a team of reviewers from DOE and NREL selected the following teams to compete in 2007:

- California Polytechnic State University, San Luis Obispo, California
- Carnegie Mellon University, Pittsburgh, Pennsylvania
- Cornell University, Ithaca, New York
- Georgia Institute of Technology, Atlanta, Georgia
- Kansas State University, Manhattan, Kansas
- Lawrence Technological University, Southfield, Michigan
- Massachusetts Institute of Technology, Cambridge, Massachusetts
- New York Institute of Technology, Old Westbury, New York
- Team Montreal (École de Technologie Supérieure, Université de Montréal, McGill University), Montreal, Canada
- Technische Universität Darmstadt, Darmstadt, Germany
- Texas A&M University, College Station, Texas
- The Pennsylvania State University, University Park, Pennsylvania
- Universidad de Puerto Rico, Río Piedras and Mayagüez, Puerto Rico
- Universidad Politécnica de Madrid, Madrid, Spain
- University of Cincinnati, Cincinnati, Ohio
- University of Colorado, Boulder, Colorado
- University of Illinois at Urbana-Champaign, Urbana, Illinois
- University of Maryland, College Park, Maryland
- University of Missouri-Rolla, Rolla, Missouri
- University of Texas at Austin, Austin, Texas

## The 10 Contests

The Solar Decathlon organizers have selected the following 10 contests for the 2007 Competition. The teams can earn up to 100 points for each contest except Architecture, for which they can earn up to 200 points and Engineering and Market Viability, for which they can earn up to 150 points. Of the 1200 total points possible, 525 points are awarded based on objective performance measurements or task completion, and 675 points are awarded through subjective evaluations by a variety of appropriately selected experts. For details about scoring: [The Contests](#).

### ***Contest 1: Architecture***

To be architecturally sound, a home's design must not only satisfy human comfort needs, it must also be well organized and visually pleasing both inside and out. The Architecture contest is intended to demonstrate that solar-powered, energy-efficient homes can be designed to meet enduring architectural standards. A jury of architects will judge each entry on the overall aesthetics and the successful design and integration of the solar, energy-efficiency, and other technical features of the house. The jury will evaluate the houses early in the week of contests and will not be influenced by the objectively measured performances of the houses. For more details see [Contest 1: Architecture](#).

### ***Contest 2: Engineering***

Although architects are critical collaborators in the engineering design of well-integrated high performance homes, engineers and other technical experts possess unique skills that are required to design, specify, install, and maintain the house's systems. A jury of technical experts in the residential building industry will judge each entry on the functionality, efficiency, innovation, robustness, and economic value of the house's building envelope, environmental control, mechanical, electrical, and plumbing systems. For more details see [Contest 2: Engineering](#).

### ***Contest 3: Market Viability***

An important objective of the Solar Decathlon is to prove that homes containing solar and energy-efficient design and technologies are market ready and belong in the world's diverse neighborhoods. Experts from the building industry will compose the jury for this contest. Judging will take place early in the week of contests and will not be influenced by the objectively measured technical performance of the houses. For more details see [Contest 3: Marketability](#).

### ***Contest 4: Communications***

The Solar Decathlon is a competition and a public event. The Communications contest challenges teams to communicate their experiences in this project to a general audience. Through Web sites and public tours, the teams will share the knowledge they have acquired. Their experiences and their houses will serve as living demonstrations of the viability of solar energy and energy efficiency technologies in the home. Panels of judges with expertise in communications and public relations will award points based on subjective evaluations of the teams' Web sites and house tours. For more details see [Contest 4: Communications](#).

### ***Contest 5: Comfort Zone***

Well-designed houses provide a safe and comfortable indoor environment for occupants through heating, cooling, humidity, and ventilation controls. In this contest, the teams will be evaluated objectively on their ability to maintain temperature and relative humidity within prescribed set points. Other aspects of indoor environmental quality will be evaluated in Contest 2: Engineering. For more details see [Contest 5: Comfort Zone](#).

### ***Contest 6: Appliances***

A house is not a home without kitchen appliances, laundry facilities, and electronics such as personal computers and TV/video players. This contest requires the teams to demonstrate that their houses can provide the necessary energy to effectively operate appliances and electronics. The teams will store food in their refrigerators and freezers, host a dinner party, wash dishes, and do laundry during the week of contests. The teams will also be required to operate their personal computers and TV/video players a set number of hours each day. All points for this contest will be awarded based on task completion and objective performance evaluations of the required appliances and electronics. For more details see [Contest 6: Appliances](#).

### ***Contest 7: Hot Water***

This contest demonstrates that the teams' houses can provide all of the energy necessary to heat water for domestic uses. Teams will receive points for performing tests that simulate the average time and temperature requirements for two showers each day of the contest week. Twice per day, teams will have to deliver 15 gallons (56.8 liters) of hot water (at least 110°F [43.3°C]) in no more than 10 minutes. For more details see [Contest 7: Hot Water](#).

### ***Contest 8: Lighting***

Sunlight, moonlight, and electric light all contribute to the livability and environment of a dwelling, inside and out. Lighting systems should be designed to minimize energy use by maximizing the contribution of daylighting and by using controls to minimize the use of electric illumination. This contest evaluates the quantity and quality of the lighting in the houses both day and night. Points will be awarded on a team's ability to provide acceptable lighting levels for specified durations. A jury of lighting experts will award points on the basis of subjective evaluations of the teams' lighting system designs. For more details see [Contest 8: Lighting](#).

### ***Contest 9: Energy Balance***

This contest demonstrates that the sun can supply the energy necessary for all the daily energy demands of a small household. The object is to produce as much or more energy than the house consumes over a defined period of time to demonstrate that the house and its systems function sustainably. Points will be awarded based on each team's ability to use their solar electric systems to produce as much electrical energy as they require during the contest week. For more details see [Contest 9: Energy Balance](#).

### ***Contest 10: Getting Around***

Because the amount of energy households use to meet their personal transportation needs is so significant, this contest is designed to demonstrate that a house itself can be used to provide that energy. The contest evaluates how much "extra" energy the houses can generate to provide transportation for the teams in street-legal, commercially available electric vehicles, which will be provided by the organizers. All points for this contest will be awarded based on objective evaluation—the more miles the teams drive, the more points they get. For more details see [Contest 10: Getting Around](#).